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5. Name of your agent (*if you have one*)
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Country	Priority Application number (*if you know it*)	Date of filing (*day/month/year*)
GB	0205974.9	14th March 2002

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DESCRIPTION

AUTOMATIC DISCOVERING OF WEB SERVICES

This invention relates to a method for automatically discovering web services from a networked CE (consumer electronics) device using UDDI (Universal Description, Discovery and Integration). This invention also relates to the enhanced discovery of TV Anytime web services using UDDI taxonomies.

The term "web service" refers to the use of an Internet server to provide useful functionality or data to a remote client. By utilising standard protocols (often SOAP, XML and HTTP) it is possible for a large range of devices (PCs, PDAs, mobile phones, etc.) to utilise these services. More importantly, these protocols allow software to automatically exploit the service without the need for human interaction, unlike a web site. Some web services will be particularly useful to consumer electronics devices, for example:

- A grocery shopping web service that allows a device to order items automatically. This could be used by a fridge, for example.
- A music web service that provides enhanced information on artists, recordings and concerts. A CD or MP3 player could use this.
- A TV schedules web service that provides data on programmes and when they are broadcast. A Personal Digital Recorder (PDR) or Integrated Digital TV would use this service.

1. State of the art

For more capable networked devices (PCs, PDAs) a number of user driven means already exist for finding new services:

- The user manually enters the URL of the service. This is inconvenient, error prone and tends to favour the technically minded user. It also requires the device to have a means of text input.

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- A search engine finds these services. This requires all services to be able to indicate compliance to a certain web service interface, and therefore requires the search engine to be modified in such a way that it can identify this compliance. It also requires a protocol to be defined for allowing the device to retrieve the found services from the search engine.
- The device has its software or data cache upgraded over the network. Such a solution requires the manufacturer or some third party to provide a service for tracking new compliant web services and then sending the new software to the device. Such upgrades are not always feasible in a cheap embedded device.

It can be seen that this invention is particularly useful in lightweight CE devices that will often not be able to use any of the above three solutions.

2. The problem

Consider a CE device, which is able to use one or more web services to provide enhanced functionality and data to the user. It will be necessary for all the web service that the device uses to have a well-defined interface, which is supported and understood by the client device. At the point of sale the device will be pre-programmed with the location (i.e. URL) of a number of these services, which the device makes use of both automatically and as a result of user interaction. After this time it is likely that other businesses will provide new and enhanced, yet technically compatible, web services. The device has no systematic way of discovering these services and offering them to the user.

Up until now web based services have been predominantly HTML based and user driven. Standards to allow computer programs to communicate without user intervention have existed for a long time (e.g. Distributed COM) but these have not been suitable for small devices. It is only with the advent of IP/HTTP and the recent development of XML that the use of completely platform independent web services, which can be realistically used by lightweight CE devices has become feasible. Addressing the issue of discovering such services in a non-proprietary fashion is even more recent and

has been the goal of the Universal Description, Discovery and Integration project. However, this work has been targeted at e-commerce and business-to-business transactions. The specific needs of CE devices have not been considered.

3. What is proposed

This invention proposes a method for how such devices can automatically find new and compatible services, as they become available. The novel aspect is that it does this in a fully automatic fashion, which requires no intervention from the user. In this way, the device is able to offer the user a greater choice of services as they become available after the user bought the device. For example, in the case of a fridge, if a new store opened nearby which provides a grocery ordering web service, it would be possible for the device to alert the user of this fact, and also to be sure of the technical compliance of that service.

UDDI makes available structured information on registered web services via a well-defined interface, in a well-known location. When a service provider (i.e. the shop or the TV schedule listing provider) offer a new service they publish the details on a UDDI node and register it as being compliant with a particular web service standard (such as TV Anytime for TV schedules). This standard will have a unique identity (tModel) in the UDDI registry. When a CE device then queries the UDDI node it uses this unique identity to find compliant services. It is further proposed that the device can exploit other registered categorisation taxonomies to refine the search for services. For example, ISO 3166 is a global geographic classification taxonomy that a device could use to make sure that a shopping service was being offered by a shop in reasonable geographic proximity. Alternatively, by registering a genre taxonomy it would be possible to search for TV Anytime web services that specialise in movie information, say.

The following steps are required for implementation of the method:

1. A standards body (or similar initiative) standardises a web service interface suitable for a class of CE devices.

2. This service is registered with a UDDI node and is assigned a UUID (universally unique identifier) for that standard interface (using the UDDI save_tModel API).

3. Service providers produce implementations of this standard interface. They register the new service using the save_service API, assuming that the business itself has already been registered with UDDI. The enclosed bindingTemplate will contain a reference to the UUID of the tModel registered in 2. At this stage they may also assign further standardised categorisations to their service (e.g. a retail service registers that it is based in London and offers pet food.). The categorisations are added using the categoryBag sub-element of the businessService element.

4. A CE device is designed which is able to use the standardised web interface.

5. After being sold, the device queries a UDDI node to find services which support this interface. To do this the find_business API is used containing just a tModelBag argument with a reference to the required tModel. A list of services is returned to the device, which can then be further refined automatically (based on machine-readable service descriptions) or by the user (based on brand preferences, recommendations, etc.).

6. Depending on the service type it is possible that the device can target its service discovery in an improved fashion. E.g. only find shops which are nearby, only find TV listing services for channels which the set top box is capable of showing, etc.

This defines a mechanism by which CE devices can use UDDI (Universal Description, Discovery and Integration) to discover web services. Such a mechanism can be used to discover TV Anytime web services, and by assigning taxonomies to implementations of these web services it is possible to provide a better means of finding a useful service. A number of problems arise when trying to discover TV Anytime web services that fulfil a particular purpose (such as a service that specialises in movie information, or a service

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that offers information on programmes available in the local area). This application describes in detail the taxonomies that should be assigned to TV Anytime web services and how a TV Anytime device can exploit UDDI to greatly improve the way in which web services are discovered.

First of all, it is necessary to consider how UDDI will be used to discover TV Anytime web services. The procedure outlined above is explained in more detail here.

Registering the TV Anytime Services Specification

The TV Anytime Forum must first register its web service interfaces with a UDDI node registry. A *tModel* will be published for each of the TV Anytime web service types. For this purpose, the UDDI *save_tModel* publication API is used. The registry will assign a unique *tModelKey* to the tModel and this key will act as a global identifier for that web service protocol.

Publishing Details of a Service Implementation

A web site offering TV Anytime services (i.e. a broadcaster or third party metadata provider) will publish to a UDDI node the details of their services. They register the new service using the UDDI *save_service* publication API (assuming that the parent *businessEntity* itself has already been registered with UDDI). See Figure 3.

A *businessService* (1) is created for each TV Anytime service that needs to be registered. Each *businessService* element contains a *bindingTemplate* for each of the bindings offered by that service (e.g. *get_Metadata* (2) and *searchOn_Description* (3)). The enclosed *bindingTemplates* will contain a reference to the appropriate *tModelKey* (4) created by the TV Anytime Forum in the previous stage. In this way, the *tModel* behaves as a technical fingerprint that formally indicates the TV Anytime compliance of the service.

Discovering Services from a PDR

A TV Anytime device (with return channel) will be able to understand one or more of the different TV Anytime service types. The device can query a

UDDI node to find services that offer this interface. As an example, consider a TV Anytime device trying to find a *get_Metadata* service. This can be done with UDDI by using the *find_business* inquiry API as follows. See Figure 4. This will succeed in returning a list of TV Anytime services that offer a *get_Metadata* binding. The TV Anytime device can then use further UDDI queries to obtain more information - such as the name and description - about those services. The problem is that this search lacks focus: there may exist hundreds of TV Anytime *get_Metadata* services and only some of them will be useful. In reality, the TV Anytime device wishes to discover TV Anytime devices that provide a specific service. For example, the device may wish to find a service that can offer schedule listings for BBC programmes, or a service that returns critics' reviews with the metadata it provides. This invention describes a method that makes such types of discovery possible.

It is proposed to standardise a set of taxonomies that can be used to categorise TV Anytime services. These taxonomies may be publicly defined, or defined by the TV Anytime Forum. When a service provider chooses to offer a TV Anytime service it uses the taxonomies to specify the nature of the service being offered. A TV Anytime device searching for a specific service can include the taxonomies in the search criteria, and in this way create a much more focused query. The taxonomies of Figure 5 are useful for categorising TV Anytime services.

There are many scenarios when use of taxonomies will greatly enhance the way in which TV Anytime web services can be exploited. To illustrate this, consider the example of a newly purchased DVB (Digital Video Broadcast) set-top-box trying to create an enhanced EPG (Electronic Programme Guide) based on TV Anytime data downloaded over the return channel. The set-top-box wishes the EPG to be in French (established from a user preference, say), and to display information on a known set of DVB locators (obtained from DVB-SI). To enable the construction of an EPG, the service will need to offer a *searchOn_Delivery* and *get_Metadata* binding. The following sections describe the additional steps to those outlined above, and illustrate how the use of taxonomies enable the discovery of services required by this scenario.

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Registering the TV Anytime Taxonomies

TV Anytime will need to additionally register unchecked category-type *tModels* for the taxonomies it chooses to standardise (see http://www.uddi.org/pubs/TN-taxonomy-provider-V1.00-Final-20010717.pdf). This will result in each taxonomy having a unique *tModelKey*. The specification of each taxonomy will define the allowable values that the taxonomy can take (e.g. a genre taxonomy might be an enumeration of strings), and the semantics associated with those values. Note that it is also possible for parties to register and use new taxonomies not standardised by TV Anytime. Standard TV Anytime device will not be able to exploit such taxonomies, but proprietary implementations will be able to.

Publishing Details of a Service Implementation

The method of publication will be the same as that described in the section above with the same title. In addition, the message will include a *categoryBag* element containing the taxonomies that the service provider chooses to assign to that service. For the above scenario, a matching service will have assigned itself a language taxonomy of French, and at least one DVB locator taxonomy corresponding to a DVB service available to that set-top-box.

There are no limits on the number of taxonomies that can be assigned to a service and it is possible to assign a service more than one value of the same taxonomy type (i.e. there can be multiple *keyedReference* elements with the same *tModelKey* attribute value).

Discovering Services from a PDR

To restrict the search, a *categoryBag* element is included in the search for services. See Figure 6. The *categoryBag* element (1) specifies a set of taxonomies that the matching service must conform to. In this case, the matching service must provide metadata in French and must offer scheduling information on the indicated DVB channels. This search qualifier (2) has the effect that the DVB locators are treated in an OR fashion. In other words, a service only has to match one of the DVB locators to return a match. This

prevents the set-top-box from needing to make multiple searches each containing a *keyedReference* with a single DVB locator.

According to a first aspect of the present invention, there is provided a method for automatically discovering web services comprising querying a known UDDI server address containing a list of web services, identifying from said list suitable web services, and automatically downloading at least one machine readable description of a web service.

According to a second aspect of the present invention, there is provided apparatus for automatically discovering web services comprising communicating means for querying a known UDDI server address containing a list of web services and identifying from said list suitable web services, said communicating means arranged to automatically download at least one machine readable description of a web service.

The main advantage of such an approach is that it doesn't require user browsing or keyboard input. This makes it particularly appropriate for lightweight embedded CE devices that will generally not have technical users.

The suitable web services are those that the querying device can use to enhance its functionality. The identifying stage is based upon the structure of the defining protocol that categorises the web services. In this way all devices can use the same methodology for obtaining web services, with only those appropriate to the requesting device being returned. Web services can be easily added and devices already installed can periodically query the address to obtain new services.

Advantageously, if the web services being sought are TV Anytime web services, then the querying contains a specific request, limiting the type of TV Anytime web service identified. In this way a TV Anytime device such as a PDR can make a search for suitable web services that is limited to a particular type of service.

4. Fields of application of the invention

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In general the invention could be exploited by any network enabled CE device which makes use of a web-service that is based on an open standard. Some obvious examples have already been given. Other uses are:

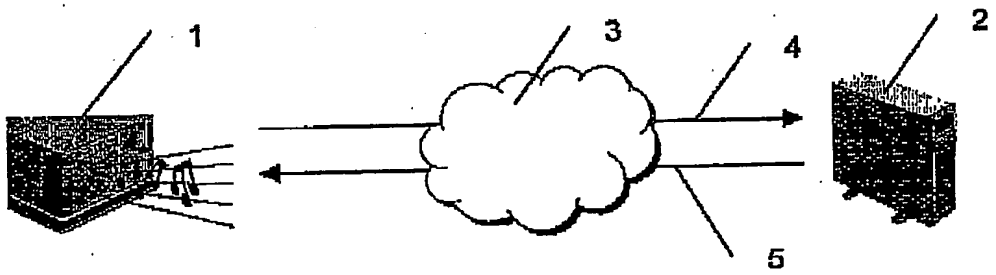
- Digital Audio Broadcast receiver could obtain improved programme listings.
- An oven or microwave that can exploit a standard "recipe finder" web service.
- Any device could use a web service to indicate that it has a fault or requires servicing and needs to call out a technician.

5. An example of the invention

Figure 1 illustrates a conventional operation of a network-enabled, embedded device, and Figure 2 illustrates the enhanced operation of a network-enabled, embedded device, as an example of the invention. Figures 3 to 6 (described in more detail above) refer to a TV Anytime implementation.

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Conventional operation of a network-enabled, embedded device

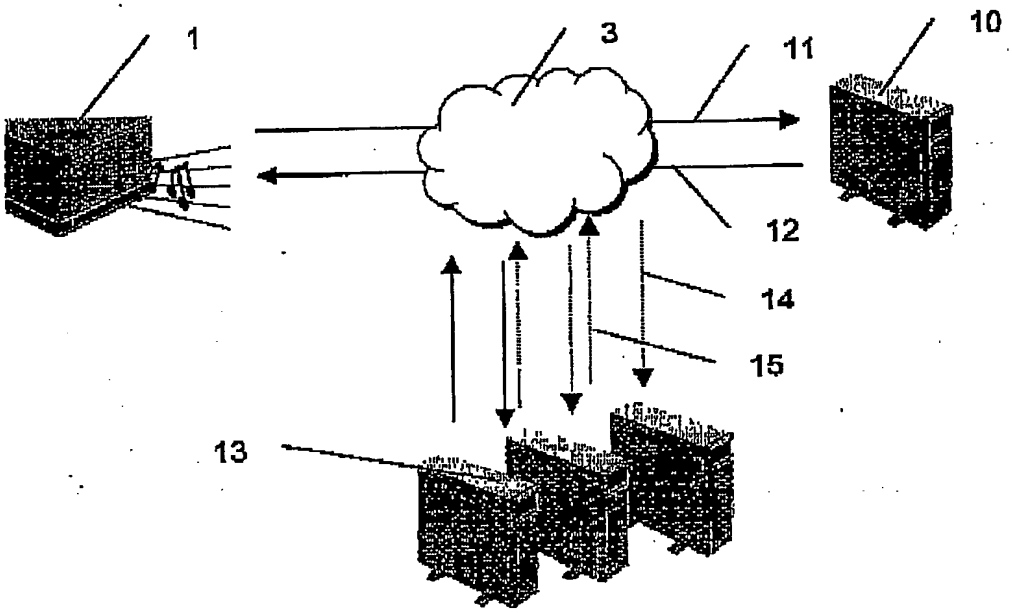


1. Network enabled embedded device (such as a Digital Audio Broadcast receiver).
2. Remote network server, offering a related web service (such as track listings, information on artists, etc.).
3. A wide area network (such as the Internet).
4. A structured query from 1 to 2 (such as a SOAP request for information on a particular song).
5. A structured response from 2 to 1 (such as a SOAP response containing the information on a particular song).

Fig 1

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Enhanced operation of a network-enabled, embedded device

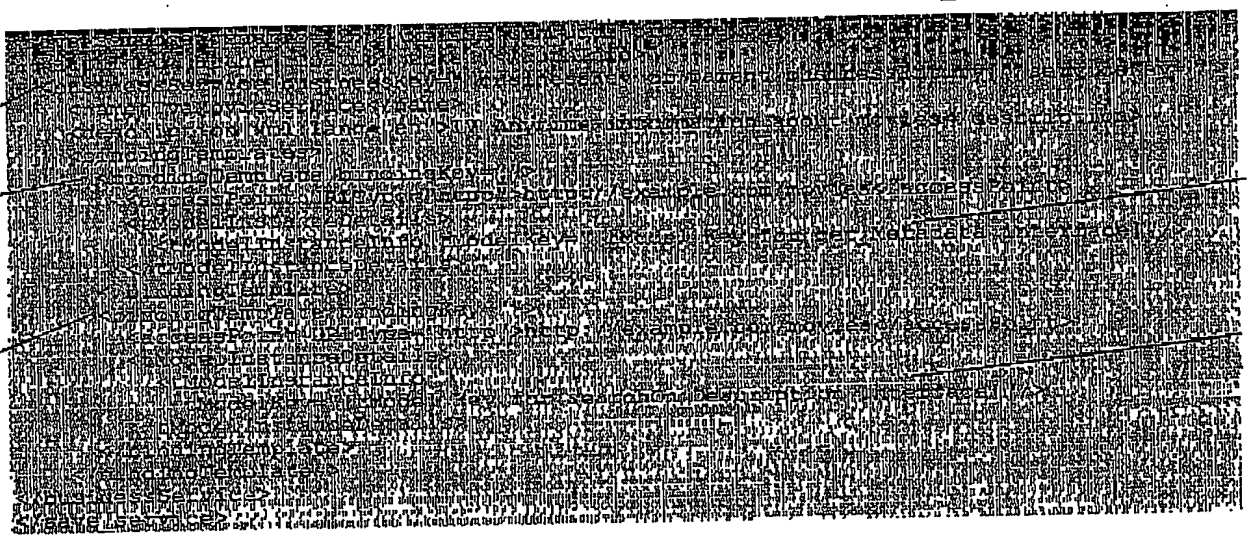


10. A UDDI server (at a well-known URL).
11. A structured UDDI query from 1 to 10 (such as a request for web services which are technically compliant with 2 and offer information for radio broadcasts within the UK).
12. A structured UDDI response from 10 to 1 (such as a response containing the information on those services which satisfy the criteria of 11).
13. One or more new-found web service. These web services are distinct, may have been set up after the device 1 was sold, and are all technically compliant with 2 (i.e. they can be successfully used by device 1).
14. A structured query from 1 to 13.
15. A structured response from 13 to 1.

Fig 2

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Fig 3



A *businessService* (1) is created for each TV Anytime service that needs to be registered. Each *businessService* element contains a *bindingTemplate* for each of the bindings offered by that service (e.g. *get_Metadata* (2) and *searchOn_Description* (3)). The enclosed *bindingTemplates* will contain a reference to the appropriate *tModelKey* (4) created by the TV Anytime Forum in the previous stage. In this way, the *tModel* behaves as a technical fingerprint that formally indicates the TV Anytime compliance of the service.

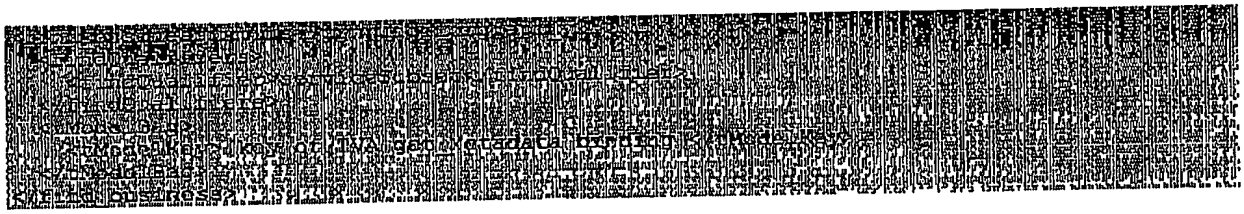


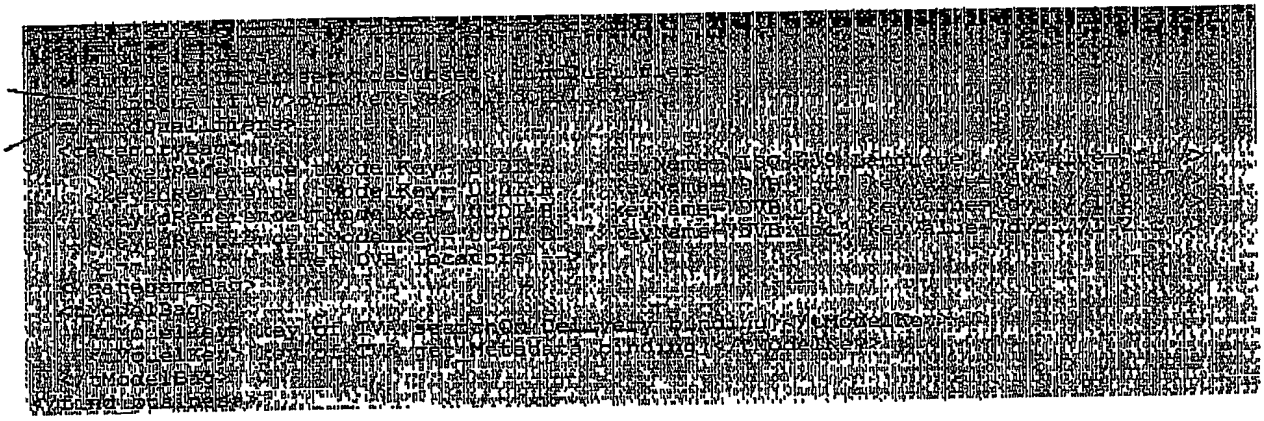
Fig 4

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Taxonomy type	Usage	Example
Authority name	Used to classify which CRID authorities are handled by that service.	Client wishing to find metadata on a CRID from a particular authority.
Broadcast service	Indicates the channels that the web service can offer information on. Will typically take the form of a DVB locator, or equivalent.	Client wishes to find TV schedule for a particular set of channels.
Language	Used to indicate the language that metadata is provided in.	Client wishes to construct an EPG in a particular language.
Genre	Used to indicate that the service specialises in a particular class of programmes. TV Anytime will need to specify a map from its genre types onto a flat string that can be placed inside the *keyValue* attribute.	Client searching for services specialising in football.
Geographic location	Used to specify a particular geographic region for which program information is provided, e.g. region of coverage of terrestrial broadcast.	Client searching for data on programmes available in a particular US region.
Content format	Used to indicate that the service specialises in providing content locators that correspond to a particular format type (e.g. MPEG-4, mp3, etc.).	Client searching for a service which offers information about MPEG-4 content.
Service usage rights	Some web services will charge for use and will have rights associated with how they are used.	Client searching for free web services.
Table types	Used to show the table types (contained in a *ProgramDescription* element) which this service is able to return.	Client searching for services that provide review or programme segmentation information.
Queryable fields	Used to indicate the fields that a *searchOn_Description* binding can be queried on.	A user, searching for information on an actor, needs to find services that support queries on the actor field.

Fig 5

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The *categoryBag* element (1) specifics a set of taxonomies that the matching service must conform to. In this case, the matching service must provide metadata in French and must offer scheduling information on the indicated DVB channels.

This search qualifier (2) has the effect that the DVB locators are treated in an OR fashion. In other words, a service only has to match one of the DVB locators to return a match. This prevents the set-top-box from needing to make multiple searches each containing a *keyedReference* with a single DVB locator.

Fig 6

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